REMARKS

This is in response to the Office Action dated December 30, 2004. A response was due March 30, 2005, without an extension of the time for response. A one month extension of the time for response until April 30, 2004 is submitted with this response.

Claims 1-30 are pending in this application. Claims 21-26 are subject to a final restriction requirement. Claims 28-31 have been miss-numbered since there was no Claim 27 included in the current filing of this application, therefore the claims have been renumbered as Claims 27-30. Therefore, Claims 1-30 are in the application.

Claims 21-26 have been cancelled in response to the final restriction requirement.

The Examiner has requested drawings and they are enclosed with this response.

Claims 1-2, 4-5, 7-20 and 27-30 are now pending.

Claims 12-20 were rejected under 35 U.S.C. 112, second paragraph, as being indefinite with regard to the recital of "said core". The claims as presently amended are believed to remove the indefiniteness by providing a basis for the use of "said core".

The present invention is directed to a fiber-reinforced composite spring made by shaping a spring wire to form a spring. The spring wire has a core that includes a plurality of fiber tows twisted about a longitudinal axis to create a core having a contoured core surface and an outer layer of resin that is substantially devoid of fiber tows. The outer layer is formed by further twisting the core to remove a portion of the resin from the core to create a thickness that varies along the longitudinal axis and forms a general uniform outer surface about the core and a cross section having substantially constant diameter. The spring wire structure is used to produce a spring having a predictable rate of deformation when subjected to a compressive load as defined in the claims.

As can be appreciated, a plurality of fiber tows twisted about a longitudinal axis describe *e.g.* a rope like structure such as is disclosed in the prior art patents and is described in the present application. This results in a surface that is not uniform due to the contours of the surface of the twisted structure.

Without further processing, a rope structure impregnated with a resin, when cured, will result in a rope where the surface is similar to the surface of the rope. Even where some of the resin resides on the surface of the rope due to the saturation process, it is expected that the surface will be irregular due to the inherent nature of the curing process since the cure process will draw the excess resin toward the surface of the rope. This would be true even if the rope were confined in a tube during

the cure process. A spring made from such a structure will not have a predictable rate of deformation since the rope structure will not have a substantially constant diameter.

The present invention achieves a predictable rate of deformation. This is due to the fact that the outer layer is formed by twisting the fibrous tows core after it is placed in a cavity to create a excess of resin and a resulting spring wire that has a generally uniform outer surface and a substantially constant diameter. This is not taught by the cited prior art references.

Claims 1-5, 9-20 and 27-30 (current numbering) have been rejected under 35 U.S.C. (b) as being anticipated by U.S. Pat. No. 6,454,251 to Fish, U.S. Pat. No. 2,852,424 to Reinhart et al, U.S. Pat. No. 4,473,217 to Hashimoto, and U.S. Pat. No. 4,991,827 to Taylor. Claims 6-7 are rejected under 35 U.S.C.(a) as unpatentable over Fish, Taylor, Hashimoto or Reinhart et al in view of U.S. Pat. No. 6,612,556 to Petrina. Petrina has been cited for its teaching of a rectangular cross-section for the spring wire.

Fish is directed to a composite core assembly used to fabricate high performance structures, such as springs. In one form, the core assembly is composed of an inner composition of structurally fibrous material and an external cladding. Resin is impregnated into the fibrous material, and the external cladding functions as a containment device for liquid resin material during the fabrication of structural parts. While the fiber tows are twisted about a longitudinal axis to create a contoured core surface, there is no teaching of twisting the fiber tows after they are confined by the cladding to remove a portion of the resin from the fiber tows and create a cross section having a substantially constant diameter, as is claimed in the present invention.

Reinhart et al teach reinforced plastic springs made by subjecting the tubing to an opposing twist when wrapping it around the mandrel to redisburse the concentration of glass reinforcing. This is not a teaching of twisting the core to remove a portion of the resin and form an outer layer with the predictable rate of deformation performant to the present invention. Reinhart et al does not teach or suggest the kind of uniformity claimed in the present invention which provides the improved performance of the present invention.

Hashimoto is directed toward a fiber-reinforced resin coil spring and method of manufacturing the spring. The Hashimoto spring is formed by a spring wire comprising a plurality of bundled glass fibers that are impregnated with a thermosetting resin. Once impregnated, the bundled glass fibers are subjected to a tensile force and twisted about a longitudinal axis to form a resin-immersed and twisted rod-shaped fiber bundle. Column 2, lines 61-65. Hashimoto notes that the

resin impregnated within the fiber bundle is slightly squeezed out by the twisting step, and as a result, the content of the fiber in the rod-shaped fiber bundle is increased. So, Hashimoto is densifying the fiber content, and is not making a substantially constant diameter. In fact, Hashimoto applies an outer fiber layer after twisting the fiber bundle to achieve the desired elastic characteristic has been completed, "a water-soluble vinyl alcohol tape is wound on the rod-shaped fiber bundle in an opposite direction to the twisting direction of the resin-immersed bundle and twisted rod-shaped fiber bundle to thus form a winding fiber bundle." Column 3, lines 7-12. Thereafter, the fiber bundle wound with the vinyl alcohol tape is wound along a coil shaped groove formed in a mandrel to shape the fiber bundle into a coil spring. Column 3, lines 15-20. Hashimoto does not teach or suggest an outer layer formed by twisting the core to remove a portion of the resin from the core and create an outer surface which has a cross section having a substantially constant diameter to thereby produce a spring having a predictable rate of deformation when subjected to a compressive load in accordance with the present invention.

Taylor discloses a spring formed from a rope that has been pressure-saturated with a binder. The rope comprises a plurality of twisted strands, each containing a plurality of monofilaments. The strands are combined with a binder such that the rope is saturated with the binder under pressure to cause the binder to enter all of the spaces between the monofilaments and form an outer layer on the outer periphery of the rope. See Column 3, lines 52-63 and Figure 3. After the rope has been saturated, it is permitted to drain to remove the excess binder. Thereafter the drained rope and binder combination is pulled through a tubular sheath, causing the rope to retain its saturated condition an d shape, as well as to permit handling of the saturated rope without subjecting the operator to the binder. See Column 4, lines 15-26. Pressure pulses can be applied to the external surface of the sheath to enhance saturation of the binder into the rope. See Column 4, lines 26-28. An optional further step is inserting the sheath into a housing to which high pressure fluid is applied to a chamber formed between the external surface of the sheath and the internal surface of the housing. The pressure thus applied to the external surface of the sheath produces compaction of the rope and binder to increase the ratio of filament to binder to thereby improve the spring strength. See Column 4, lines 33-40. Thus, the binder is being forced inward into the core of monofilaments due to the external-applied pressure from the high pressure fluid. Even if an outer layer is formed, the process minimizes the thickness of the outer layer of binder and forms an outer surface on the rope exhibiting the contours of the underlying monofilaments that are wound together. Thus, Taylor does not

suggest or teach twisting the core to remove a portion of the resin from the core to form an outer surface having a cross section which is substantially constant in diameter so that a spring having a predictable rate of deformation when subjected to a compressive load as defined in the claim, can be formed.

The deficiencies of Fish, Reinhart, Hashimoto and Taylor are not cured by the teachings of Petrina. Petrina teaches a single spring unit which includes a multi-helical spring formed of composite materials. While Petrina teaches that the wire can be rectangular in cross section, this does not suggest or teach a cross section having a substantially constant diameter to produce a spring having a predictable rate of deformation when subjected to a compressive load, as is claimed in the present claims.

The Examiner has also rejected the claims on the basis of double patenting. Since Applicants prior co-pending patent application, Serial No. 09/871,755, has been abandoned in favor of the present continuation-in-part application, the double patenting rejection should no longer apply. Therefore reconsideration and withdrawal of the rejection is respectfully requested.

For the foregoing reasons, reconsideration of the rejections under 35 U.S.C. 102 and 103 are respectively requested, as well as the rejections, is respectfully requested. Therefore, early allowance of claims 1-2, 4-5, 7-20 and 27-29 are respectfully requested.

Should the Examiner wish to discuss any of the foregoing in more detail, the undersigned attorney would welcome a telephone call.

Respectfully submitted,

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Attachment - replacement drawing sheet
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